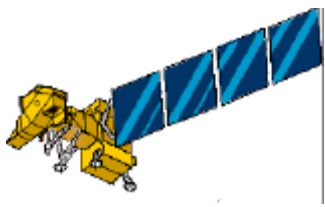


Landsat 7 Distribution Products

<u>Product Type</u>	<u>Corrections Applied</u>	<u>Format</u>
1. Level 0R	spatially reformatted	HDF
2. Level 1R	radiometrically corrected	HDF
3. Level 1G	radiometrically & geometrically corrected	HDF, Fast, GeoTIFF

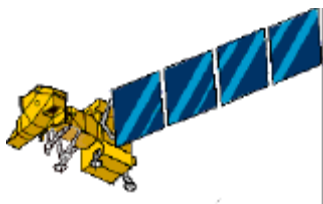


Landsat 7 0R Product

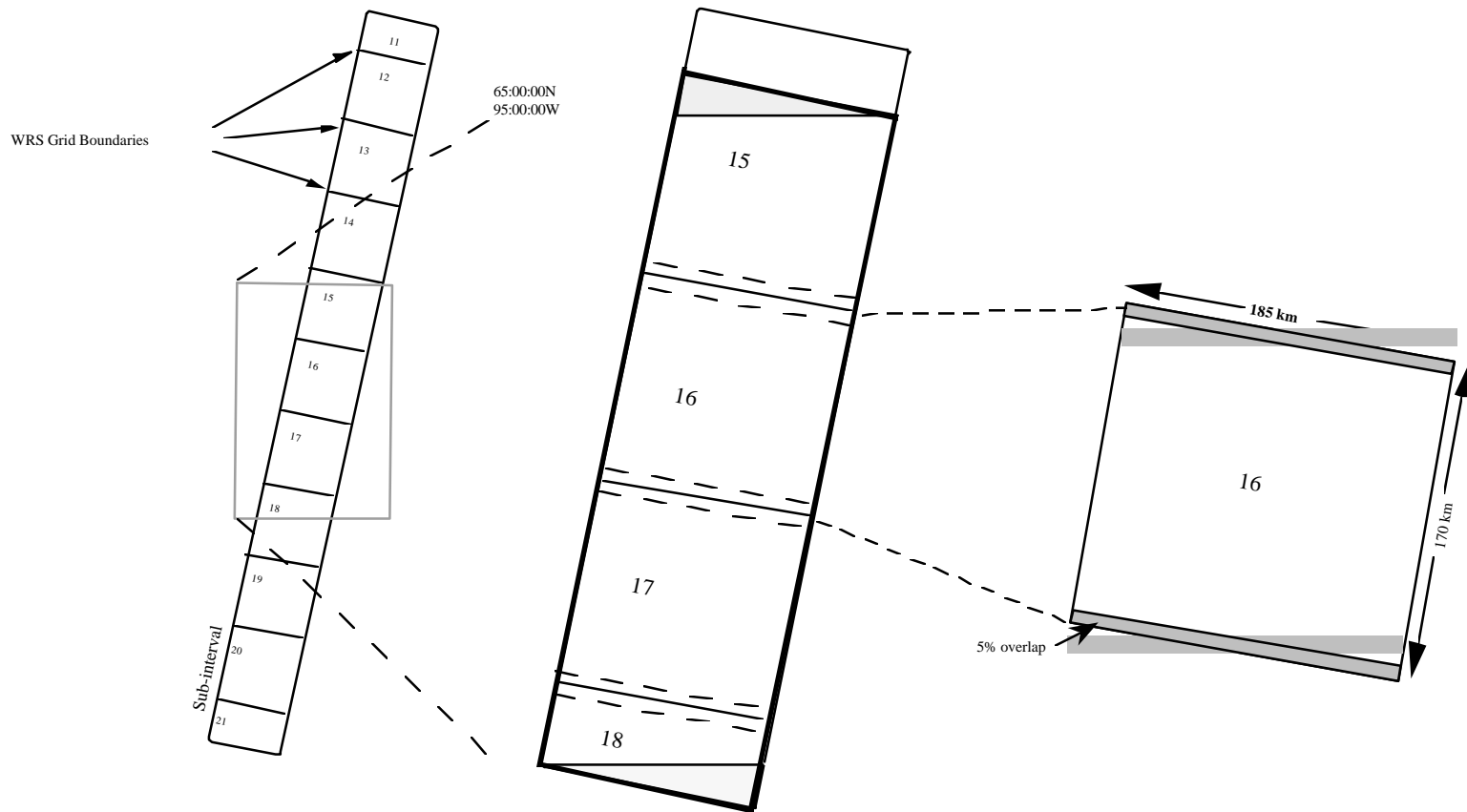
An essentially raw data product with bands spatially aligned to account for scan reversals, focal plane detector offsets, and detector timing delays.

Unique Product Features

- **image data unbounded in spatial extent (i.e. up to a subinterval)**
- **all ancillary data files required for advanced (i.e. level 1) processing accompany the product**
- **includes a frequently updated calibration parameter file for producing rectified image products of superior quality**
- **provided in a flexible format that preserves user options**
 - **a public domain library with access routines and utilities can be employed**
 - **the format does not prohibit the use of homegrown software**
- **provided at cost of filling user's request (COFUR)**



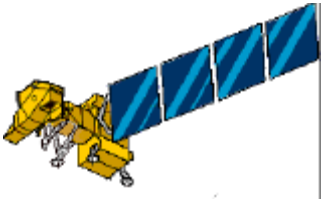
Level 0R Product Sizes



1. Sub-interval

2. Partial sub-interval
(defined by contiguous WRS
locations or geographic area)

3. Standard WRS Scene

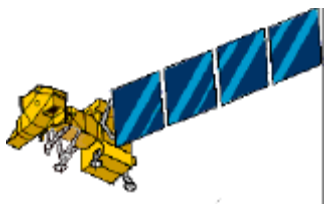


0R Product Format

Landsat 0R products are delivered to users in the Hierarchical Data Format (HDF) - an open standard chosen by NASA for Earth Observing System data products

HDF Highlights

- **A self-describing format, allowing an application to interpret the structure and contents of a file without outside information.**
- **A portable file format. HDF files can be shared across platforms. An HDF file created on one computer such as a Cray supercomputer, can be read on another system such as an Wintel PC, or Mac without modification.**
- **Supported by a software library and utilities in the public domain.**



HDF Formatting

Conceptual View of an HDF File

- **HDF employs 2 Levels of Formatting**

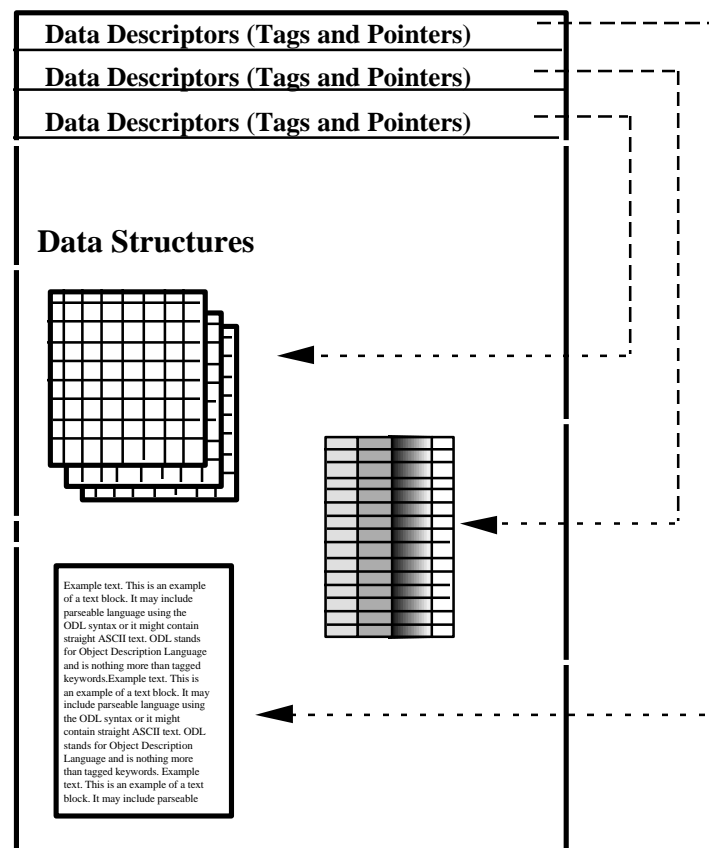
- 1. File Organization**

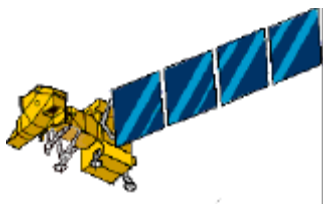
- **Data Descriptors and Pointers**

- 2. Data Organization**

- **Structure Types**
 - **N-dimensional Array**
 - **tables**
 - **text**
- **IEEE Numeric Standards**

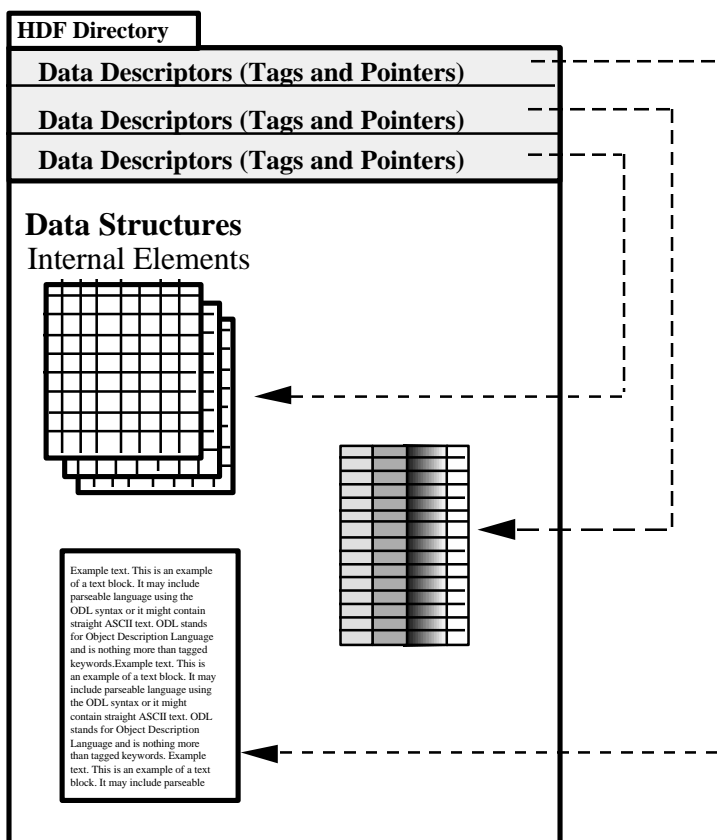
- **Use of the public domain libraries ensures adherence to both levels of formatting**



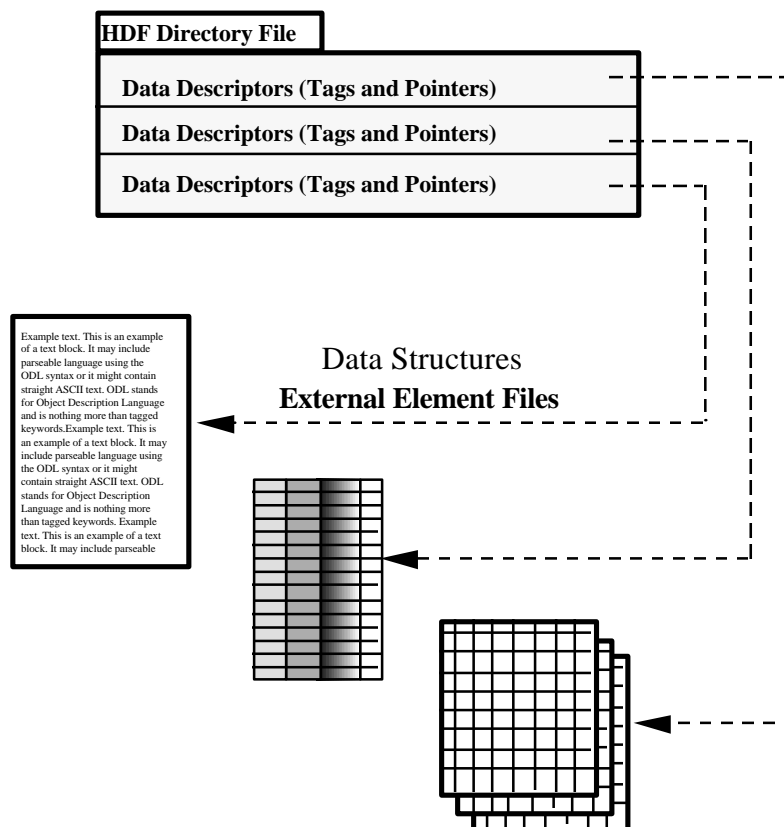


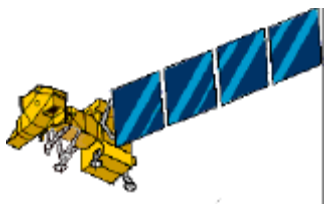
HDF Packaging Alternatives

1. Encapsulated HDF (LPS)



2. External Elements (ECS)





HDF Packaging Design

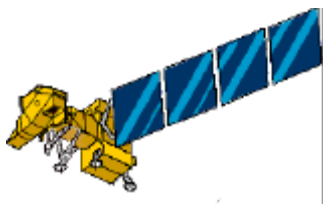
The Landsat 7 0R product is packaged and distributed as a collection of external elements. Each product consists of 21 files - 20 data components and an HDF directory.

Benefits:

- a common look and feel regardless of product size
- 100% compatibility with the HDF library
- independence (if desired) from the HDF library

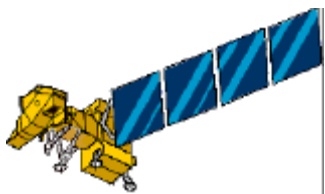
Drawbacks:

- external elements linked to the HDF Directory through file name only. Link 'rot' will occur if the external elements are renamed or moved.

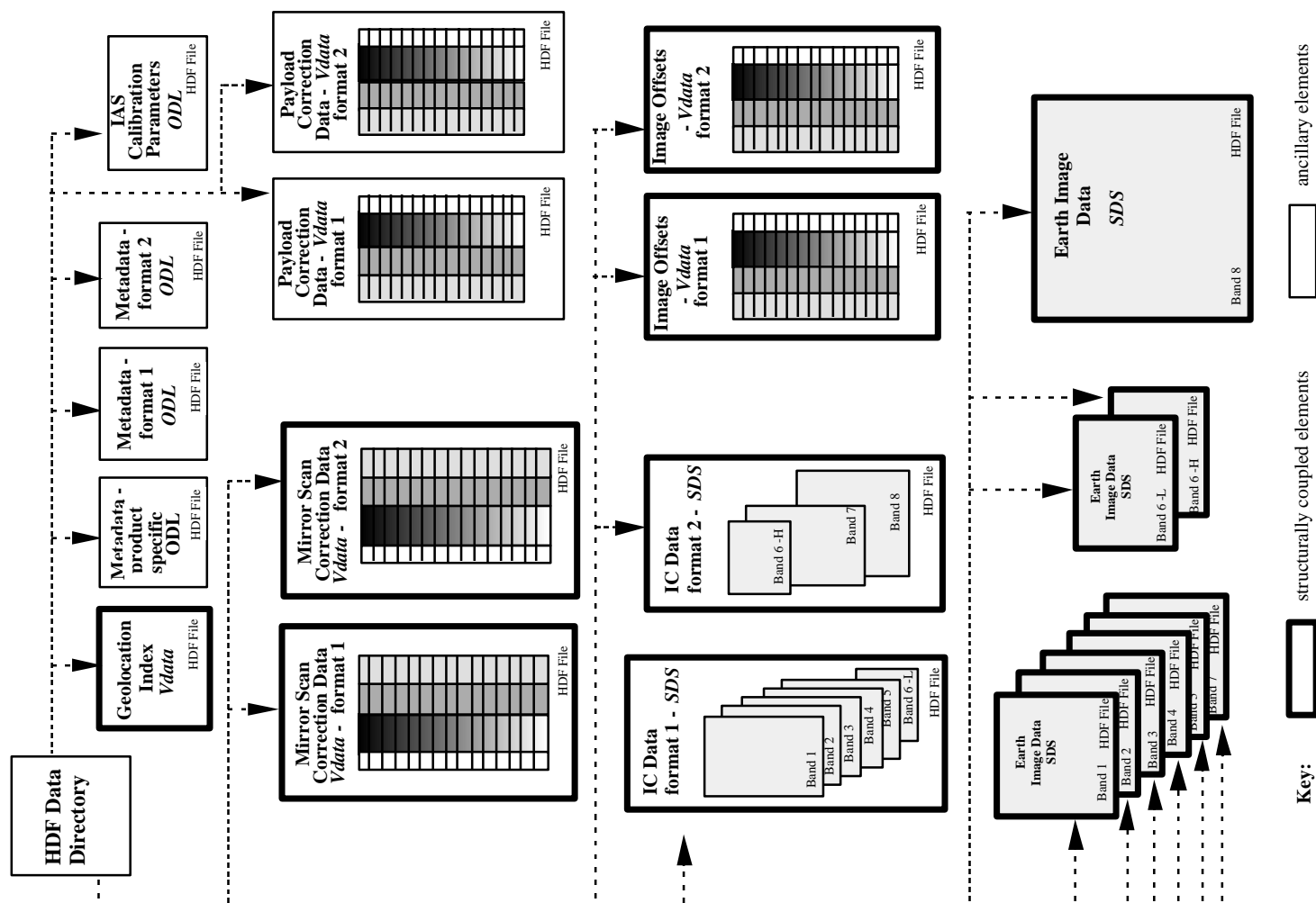


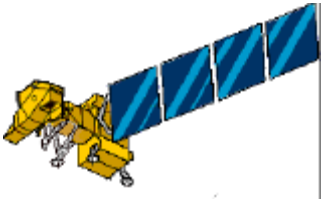
Level 0R Product Components

Component	Description	File Type	Origin
1.	Band 1 image data	Binary	Format 1
2.	Band 2 image data	Binary	Format 1
3.	Band 3 image data	Binary	Format 1
4.	Band 4 image data	Binary	Format 1
5.	Band 5 image data	Binary	Format 1
6.	Band 6 image data (low gain)	Binary	Format 1
7.	Band 6 image data (high gain)	Binary	Format 2
8.	Band 7 image data	Binary	Format 2
9.	Band 8 image data	Binary	Format 2
10.	Internal Calibrator Data (bands 1-6L)	Binary	Format 1
11.	Internal Calibrator Data (bands 6H, 7 8)	Binary	Format 2
12.	Mirror Scan Correction Data	Mixed	Format 1
13.	Mirror Scan Correction Data	Mixed	Format 2
14.	Payload Correction Data (sub-interval)	Mixed	Format 1
15.	Payload Correction Data (sub-interval)	Mixed	Format 2
16.	Metadata - sub-interval	ASCII	Format 1
17.	Metadata - sub-interval	ASCII	Format 2
17.	Metadata - product specific	ASCII	ECS
18.	Scan Line Offsets	Binary	Format 1
19.	Scan Line Offsets	Binary	Format 2
20.	HDF Directory	Binary	ECS
21.	Calibration parameter file	ASCII	IAS



Conceptualized 0R Product - External Elements





Calibration Parameter File

The calibration parameter file is created and maintained by the Image Assessment System. It accompanies every Landsat 7 0R product and is sent to the IGSs via the Mission Operations Center.

File contents include:

Geometric Processing Parameters

- nominal orbital parameters
- scan mirror profile coefficients
- focal plane band and detector locations
- alignment matrices
- gyro calibration parameters
- jitter sensor calibration parameters
- scan line corrector profiles
- ETM+ sensor data (e.g. scan line length, scan rate, scan angles)

Radiometric Processing Parameters

- gains (high & low) and offsets (pre-launch, post-launch)
- IC pulse and shutter locations
- artifact removal parameters
- MTF coefficients

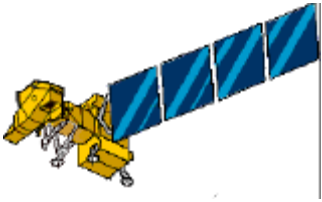


Landsat 7 1R Product

**A radiometrically corrected 0R product with known artifacts removed.
Distributed product generated by LPGS.**

Level 1R Product Characteristics

- **product size up to 3 scenes in length.**
- **image artifacts (e.g. banding, striping, coherent noise) removed prior to radiometric processing.**
- **radiometric resolution 16 bits.**
- **all ancillary data files required for geometric processing accompany the product.**
- **packaged in a flexible format that preserves user processing options (i.e. public domain or homegrown software).**

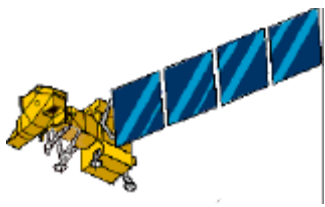


Landsat 7 1R Product Format

The Landsat 1R product is distributed in the HDF 0R format.

Level 1R HDF Characteristics

- **Product files are stored as external elements.**
- **Format 1 and 2 MSCD files are merged.**
- **Format 1 and 2 PCD files are merged.**
- **A complete product (all bands) consists of 19 files - 18 data components and an HDF directory.**

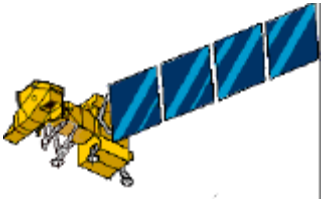


Landsat 7 1G Product

**A radiometrically and geometrically corrected 0R product.
Distributed product generated by LPGS.**

Level 1G Product Characteristics

- **Product up to 3 scenes in size.**
- **The 1G product is scaled to 8 bits.**
- **Seven map projection options: Space Oblique Mercator, Universal Transverse Mercator, Transverse Mercator Lambert Conformal Conic, Oblique Mercator, Polyconic, Polar Stereographic.**
- **Three resampling options: nearest neighbor, cubic convolution, modulation transfer function compensation.**
- **Systematic corrections only (i.e. no ground control). Geodetic accuracy - 250 meters excluding terrain effects.**
- **Three distribution formats supported.**

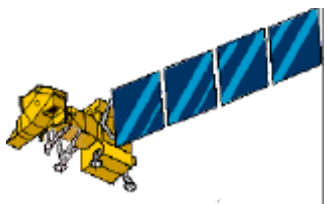


Landsat 7 1G Product Format

Option 1 - The 1G product is distributed in the HDF 0R format.

L7 1G HDF Characteristics

- **Product files are stored as external elements.**
- **Ancillary data files do not accompany the product.**
- **A complete product (all bands) consists of 11 files - 10 data components (9 bands, metadata file) and an HDF directory.**



Landsat 7 1G Product Format

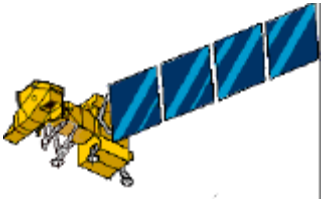
Option 2 - The 1G product is distributed in the Fast Format which has been in widespread use since 1986.

EOSAT Fast Format Characteristics

- **Product consists of a header file followed by individual band files.**
- **Header file consists of an administrative, radiometric, and geometric record.**
- **The format assumes a common output pixel size for all bands.**

L7 Fast Format Characteristics

- **Format adjusted to account for different output pixel sizes for the three band groups (VNIR/SWIR, thermal, panchromatic).**
- **A separate header file accompanies each band group.**
- **Format compatible with existing Fast Format readers.**



Landsat 7 1G Product Format

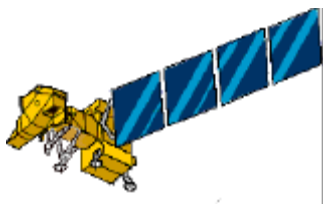
Option 3 - The 1G product is distributed in GeoTIFF format. GeoTIFF is an extension to the tagged image file format (TIFF) used worldwide by image publishing companies.

GeoTIFF Format Characteristics

- **GeoTIFF employs embedded tags for describing an image's cartographic projection, datum, ellipsoid, and pixel dimensions.**
- **Like HDF, GeoTIFF is platform interoperable.**
- **GeoTIFF is currently supported by Erdas, PCI, ESRI, Intergraph, Softdesk and MapInfo.**
- **Public domain reader/writer software available.**
- **SPOT and JPL products delivered in GeoTIFF format.**

L7 1G GeoTIFF Characteristics

- **A complete product (all bands) consists of 9 files - one grayscale GeoTIFF file per band.**
- **GeoTIFF does not support the SOM projection.**



Format Documentation

- **Volume 5, Book 1, February 1998, (NASA GSFC 430-11-06-007-0), Landsat 7 System Zero-R Distribution Product Data Format Control Book**
<http://caster.gsfc.nasa.gov/L7/L0R.Prod.Spec.2.98.pdf>
- **Landsat 7 Calibration Parameter File Definition, (NASA GSFC 430-15-01-002-0), February, 1998**
<http://caster.gsfc.nasa.gov/L7/cpf.2.98.pdf>
- **ESDIS Level 1 Product Generation System (LPGS) Output Files DFCB, Vol. 5, Book 2 March, 1998**
http://ltpwww.gsfc.nasa.gov/IAS/pdfs/lpgs_dfcb.pdf
- **GeoTIFF Format Specification, Version 1.8.1, October, 1995**
<http://home.earthlink.net/~ritter/geotiff/spec/geotiff1.html>